UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/737,013	12/16/2003	Dennis Michael Connolly	201448/443	5578

7590 10/11/2006

Dennis M. Connolly, Ph.D.
Integrated Nano-Technologies, LLC
999 Lehigh Station Road
Suite 200
Henrietta, NY 14467-9311

EXAMINER	
MUMMERT, STEPHANIE KANE	

ART UNIT	PAPER NUMBER
1637	

DATE MAILED: 10/11/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	10/737,013	CONNOLLY, DENNIS MICHAEL
	Examiner	Art Unit
	Stephanie K. Mummert	1637

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 1 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 72-108 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☐ Claim(s) _____ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) 72-108 are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Applicant's election of Group I, claims 72-90 in the reply filed on July 31, 2006 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)).

2. Claims 91-108 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention, there being no allowable generic or linking claim. Election was made **without** traverse in the reply filed on July 31, 2006.

3. Claims 72-90 are pending and will be examined.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

5. Claims 80-83, 88-90 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for the inclusion of nucleic acids in circuit elements including resistors, transistors and diodes, does not reasonably provide enablement for incorporation of nucleic acids into circuit elements including capacitors and inductors. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make the invention commensurate in scope with these claims.

Factors to be considered in determining whether a disclosure meets the enablement requirement of 35 USC 112, first paragraph, have been described by the court in *In re Wands*, 8 USPQ2d 1400 (CA FC 1988). *Wands* states at page 1404,

"Factors to be considered in determining whether a disclosure would require undue experimentation have been summarized by the board in Ex parte Forman. They include (1) the quantity of experimentation necessary, (2) the amount of direction or guidance presented, (3) the presence or absence of working examples, (4) the nature of the invention, (5) the state of the prior art, (6) the relative skill of those in the art, (7) the predictability or unpredictability of the art, and (8) the breadth of the claims."

<u>The nature of the invention</u>

Claims 80-83, 89-90 are directed to circuit elements comprising capacitors or inductors, wherein the circuit element comprises a nucleic acid template with two or more sequential regions which are coated with different materials that are at least partially conductive. The invention is in an class of invention which the CAFC has characterized as "the unpredictable arts such as chemistry and biology." Mycogen Plant Sci., Inc. v. Monsanto Co., 243 F.3d 1316, 1330 (Fed. Cir. 2001).

<u>The breadth of the claims</u>

The claims encompass circuit elements which include capacitors and inductors. The claim requires that these circuit elements comprise a nucleic acid template, coated with a conductive material.

Quantity of Experimentation

The quantity of experimentation in this area is large. This is mainly due to the fact that the methods of circuit fabrication have not been reduced to practice. Applicant has given no indication of actually fabricating a circuit comprising the nucleic acid template with conductive materials applied selectively in order to form the variety of circuit elements disclosed. While Applicant describes the essential features of the various elements in the specification, the fabrication of such a device is not described in the specification in such detail as to obviate undue experimentation by one of ordinary skill in the art. The following paragraph discusses some features of the apparatus required to practice the claimed methods that are unpredictable and would therefore require undue experimentation for reduction to practice.

The unpredictability of the art and the state of the prior art

The art of circuit formation, and particularly the area directed to nanoscale patterning of circuits, has a high degree of unpredictability as demonstrated by a survey of the art. For example, Tans expresses that "the use of individual molecules as functional electronic devices was first proposed in the 1970s. Since then, molecular electronics has attracted much interest, particularly because it could lead to conceptually new miniaturization strategies in the electronics and computer industry. The realization of single-molecule devices has remained challenging, largely owing to difficulties in achieving electrical contact to individual molecules" (p. 49, col. 1. Abstract, Tans, et al. Nature, May 1998, vol. 393, p. 49-52, 'Tans' herein). Tans goes on to disclose the fabrication of a field-effect transistor consisting of one semi-conducting single-wall

carbon nanotube connected to two metal electrodes and also notes that the device "operates at room temperature, thereby meeting an important requirement for potential practical applications" (Abstract, p. 49, col. 2). Following these general teachings, Tans provides further detail regarding the characterization of the device as a semi-conductor, presenting experiments which include establishing the current-voltage curve in multiple settings (see Figure 2) and even notes that "although we do not yet have detailed understanding of the functioning of the TUBEFET, we shall attempt to give a qualitative description by using the well-known BARITT model" (p. 51, col. 1). While the teaching provided by Tans is not directed specifically to the formation of electronic devices patterned on nucleic acid molecules or networks of nucleic acid molecules, the issues which apply to the nanotube are applicable to any variety of circuit elements formed using a variety of nanoscale molecules. Furthermore, Tans also provides an indication that the formation of a circuit element is the first step towards incorporating the element into a functional device, with an unpredictable end result.

Regarding the formation of capacitors specifically, Nishino (Journal of Power Sources, 1996, vol. 60, p. 137-147) teaches that "capacitors are made from two metallic electrodes placed in mutual opposition within an insulating material (dielectric) between the electrodes for accumulating an electrical charge" (p. 138, col. 1) and notes that "to increase the electrostatic capacity of the capacitor, it is necessary to increase the surface area, S, of the counter-electrodes, decrease the gap, d, between the electrodes, or provide an insulator (dielectric) with a high dielectric constant, ϵ, between the electrodes (p. 139, col. 1). Nishino goes on to note the variety of types of capacitors available and some of the advantages and disadvantages of each type. For example, regarding tantalum solid capacitors, it is noted that "there are two types of tantalum

electrolytic capacitors on the market: wet electrolytic capacitors which use sulfuric acid as the electrolyte and solid electrolytic capacitors which use MnO2 as the solid electrolyte". It is also noted that "although sufficient research and development is being done on solid electrolytic capacitors based on organic materials, because of the inefficient capacity achievement rate, this type of capacitor has yet to reach practical application" (p. 141, col. 2, '6.2' heading). Nishino, therefore, indicates that there is a level of unpredictability in the art of capacitor formation.

Finally, regarding the formation of inductors, Cornett et al. (WO97/42662; November 1997) teaches that "inductors formed on radio frequency (RF) or microwave frequency integrated circuits generally require large amount of die space to achieve any significant inductance. In addition to substantial space consumption, when compared to typical transistors, resistors and capacitors, the performance of integrated inductors tend to be poor" (p. 1, lines 8-14) and notes that "it is desirable to obtain a better performing inductor for integrated circuit applications" (p. 1, lines 24-25). Cornett goes on to describe the fabrication of an inductor which "has a conductive pattern, defining the inductor geometry, which is disposed within a material having a magnetic response at the operating frequency of the inductor. In the preferred embodiment, the inductor is implemented on an integrated circuit substrate by completely encapsulating a major portion of a spiral conductive pattern between layers of amorphous ferrite material" (p. 2, lines 8-13). Cornett also conducts experiments where inductors were fabricated using amorphous CuFe2O4 thin films, "a material which is electrically non-conductive or insulative, but which provides a magnetic response at radio or microwave frequencies" (p. 8, lines 32-34). Inductors fabricated in these experiments "resulted in a constant inductance up to frequencies greater than 3 gigahertz (GHz). These inductors also had a higher quality factor (Q)"

(p. 4, lines 1-4). Therefore, the teachings of Cornett indicate that there is a level of unpredictability in the field of inductor fabrication, resulting in inductors which have different degrees of performance.

Working Examples

The specification provides examples which focus specifically on each circuit element, including background regarding the specific role of the circuit element, and generally how the element would be constructed using a combination of nucleic acid, nucleic acid binding molecules and conductive materials. However, there are no experimental results or data provided, where the circuit elements were constructed or analyzed for functionality.

Guidance in the Specification.

The specification throughout teaches generally how to the different types of circuit elements, including resistors, transistors, diodes, capacitors and inductors, using nucleic acid binding molecules and combinations of different conductive materials. However, particularly for the capacitor and the inductor, there is little guidance as to what role the nucleic acid plays within the element and how the element functions.

For example, at Example 4, the specification provides a general example of the basic role and function of an inducer in a circuit, noting that "inducers produce a magnetic field which can induce current in a nearby part of the circuit. Inducers are used as transformers to change voltage in a circuit" and notes that "current moving around the coil produces a magnetic field" (p. 10, paragraph 113-114 of PgPub). The specification also teaches that one method for

producing inducers relies on the use of histone-like proteins, wherein the DNA molecule wraps around the histone, a metal or other conductive material is applied. While this disclosure and Figure 4 provides a basic understanding of how the inducer would be formed, it does not show exactly how this element would be made, how the metal wire would maintain its structure through repeated experiments, or any further details enabling one to make a circuit incorporating an inducer as disclosed in the instant application.

Furthermore, at Example 5, the specification provides a general example of the basic role and function of a capacitor as an element of a circuit, noting, "a capacitor comprises a pair of conductive layers separated by a dielectric layer. As with other electric circuit elements, DNA molecules can be used to direct the synthesis of a capacitor by directing the placement of conductive materials and/or the dielectric materials" (p. 10, paragraph 116). Furthermore, the specification generally teaches two embodiments wherein nucleic acids would be incorporated into the formation of a capacitor, see Figure 5, where parallel fragments are coated with a conductive material and are connected to leads, which may be connected to a conventional circuit. However, as noted previously, capacitors have multiple components and several associated factors which impact the function and electrostatic capacity of the capacitor, including the size of conductive layers, the space between the layers and the dielectric between the layers, for example. Specific details regarding these components are not provided within the instant application. For example, there is no indication within the specification as to how many nucleic acid molecules must be incorporated into the capacitor to provide a proper 'plate' on either side of the dielectric and based upon the teaching of the prior art, it is unclear how the capacitor would function with one, or a few nucleic acid molecules serving in the role of a capacitor.

Level of Skill in the Art

The level of skill in the art is deemed to be high.

Conclusion

The specification provides a general technique for the deposition of conductive materials or semi-conductor materials selectively to regions of nucleic acids, directed specifically to the formation of circuit elements, including diodes, transistors, resistors, capacitors, and inductors. However, the specification provides only general guidance regarding the method required to form the circuit elements, and no specific mention of the elements and features necessary to reduce the general disclosure to form an actual functional circuit which includes a capacitor or an inductor. Thus given the broad claims in an art whose nature is identified as unpredictable, the unpredictability of that art, the large quantity of research required to define these unpredictable variables, the lack of guidance provided in the specification, the presence of no working examples and the negative teachings in the prior art balanced only against the high skill level in the art, it is concluded that it would require undue experimentation for one of skill in the art to perform the method of the claim as broadly written.

Double Patenting

6. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined

application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

Claims 72-90 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-10, 15-17, 20-21, 24-25, 32-35, 38 and 44-46 of U.S. Patent No. 6,664,103 ('103 herein). Although the conflicting claims are not identical, they are not patentably distinct from each other.

The claims of the instant application and the claims of the '103 patent are not distinct from one another because they recite nearly the same language and nearly overlapping scope of the invention. The claims of the instant application are directed to a circuit, comprising at least one of a resistor, a diode, a capacitor, a transistor and an inductor. The circuit element comprises a nucleic acid template with two or more sequential regions coated with different, partially conductive materials. The claims of the '103 patent differ from the claims of the instant application in that the claims of the '103 patent are directed first to a circuit element, then individually to a resistor, a diode, a capacitor, a transistor and an inductor. While the claims of the '103 patent are recited using a somewhat different organization of limitations, the same features of the individual circuit elements, from the resistor, to the inductor are the same between the instant application and the '103 patent and therefore are not patentably distinct.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

8. Claims 72, 74-76 and 84 are rejected under 35 U.S.C. 102(b) as being anticipated by Hollenberg et al. (US Patent 5,561,071; October 1996). Hollenberg teaches construction of molecular microcircuits through the use of single or double-stranded nucleic acids and specific DNA-binding proteins (Abstract).

With regard to claim 72, Hollenberg teaches a circuit comprising:

at least one circuit element, the circuit element comprising at least one of a transistor (col. 8, lines 61-67, where the DNA networks can be used as metal oxide semiconductor field effect transistors);

wherein the at least one circuit element comprises a nucleic acid template with two or more sequential regions which are coated with different materials that are at least partially conductive (col. 9, lines 1-30, particularly step A and 1-4, where substance C and D are coated onto the DNA).

With regard to claim 73, Hollenberg teaches an embodiment of claim 72, wherein each of the different materials has a different resistivity from the other (col. 9, lines 1-30, where the substances deposited are either doped or un-doped).

With regard to claim 74, Hollenberg teaches an embodiment of claim 72 wherein each of the different materials is a doped semiconductor material (col. 9, lines 13-16, where the substance includes doped gallium, arsenide and/or silicium).

With regard to claim 75, Hollenberg teaches an embodiment of claim 74 wherein the doped semiconductor material is either an n-type or a p-type semiconductor material (col. 1, lines 24-25, where it is noted that gallium arsenide is an n- doped semiconductor).

With regard to claim 76, Hollenberg teaches an embodiment of claim 72, wherein the nucleic acid template is DNA (col. 8, lines 62, where it is noted that the nucleic acid network is DNA).

With regard to claim 84, Hollenberg teaches an embodiment of claim 72 wherein the circuit element is a transistor and the different materials comprise a first type of semiconductor material separated by a second type of semiconductor material (col. 9, lines 1-30, particularly step A and 1-4, where substance C and D are coated onto the DNA).

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

10. Claim 77 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hollenberg as applied to claims 72, 74-76 and 84 above, and further in view of Huber et al. (FASEB, 1993, vol.

7, p. 1367-1375). Hollenberg teaches construction of molecular microcircuits through the use of single or double-stranded nucleic acids and specific DNA-binding proteins (Abstract).

Hollenberg teaches all of the limitations of claims 72, 74-76 and 84 as recited above. Hollenberg does not explicitly teach that the nucleic acid may be RNA. Huber teaches complexes that cleave nucleic acids and provide a means to study RNA structure and RNA-protein interactions (Abstract).

With regard to claim 77, Huber teaches an embodiment of claim 72 wherein the nucleic acid template is RNA (Abstract, Figure 4).

It would have been *prima facie* obvious to one of ordinary skill in the art at the time the invention was made to have extended the teachings of Hollenberg directed to the formation of microcircuits through the deposition of conductive materials to nucleic acids to include RNA in addition to DNA, as taught by Huber, to arrive at the claimed invention with a reasonable expectation for success. The technique taught by Hollenberg combines the sequence specificity of DNA and DNA binding proteins in the formation of microcircuitry. However, while Hollenberg did not specifically address the inclusion of RNA into the microcircuits, the technique is applicable to double and single stranded nucleic acids. As taught by Huber, "The rules that determine RNA-protein interactions, however, appear to be more diverse, seemingly as a consequence of the complex higher-order structure found in this nucleic acid. In addition to sequence specific contacts, the recognition of RNA can depend on distinctive topologies generated by secondary and tertiary interactions" (p. 1367). Huber goes on to note the specific interactions between RNA and ribonucleases and transcription factors and discusses the analysis and determination of the specific binding regions (p. 1370-1373). Considering the teachings by

Huber, combined with the teachings by Hollenberg, one of ordinary skill in the art at the time the invention was made would have been motivated to include RNA in addition to DNA in the microcircuits formed using the technique disclosed by Hollenberg with a reasonable expectation for success.

References of interest

11. The following references may be of interest and brought to the attention of applicant, Braun et al. (US Patent 6,964,675; September 2005 and WO99/04440; January 1999) disclose a method for constructing microelectronic networks fabricated on a nucleic acid skeleton through binding conductive substances to the nucleic acids (Abstract).

Conclusion

Claims 78-83, 85-90 are free of the prior art. The closest prior art, Hollenberg, teaches construction of molecular microcircuits through the use of single or double-stranded nucleic acids and specific DNA-binding proteins (Abstract) Hollenberg also teaches that these nucleic acids may be . There is no suggestion or motivation in the prior art to extend the teachings of Hollenberg to achieve the diode, capacitor and inductor circuit elements claimed in the instant application, comprising n- and p-type semiconductors coated onto a nucleic acid template.

Claims 78-83, 85-90 are rejected for other reasons as recited above.

Claims 72-90 stand rejected.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Stephanie K. Mummert, Ph.D. whose telephone number is 571-272-8503. The examiner can normally be reached on M-F, 9:00-5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Gary Benzion can be reached on 571-272-0782. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Stephanie K. Mummert
Stephanie K Mummert, Ph.D.
Examiner
Art Unit 1637

SKM

JEFFREY FREDMAN
PRIMARY EXAMINER
9/29/05